PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference RSJ07863WO	FOR FURTHER ACTION	See Form PCT/IPEA/416
International application No. PCT/GB2004/001778	International filing date *(day/month/year)* 23.04.2004	Priority date *(day/month/year)* 25.04.2003
International Patent Classification (IPC) or national classification and IPC H04N5/217, G01N25/72		
Applicant LAND INSTRUMENTS INTERNATIONAL LIMITED ET AL.		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 6 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 8 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the opinion
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☒	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☒	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
11.11.2004	01.04.2005
Name and mailing address of the international preliminary examining authority: European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized Officer Chateau, J-P Telephone No. +31 70 340-2980

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/GB2004/001778

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3 and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4)
   - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages	
1-3, 6-17	as originally filed
4, 5, 5a	received on 24.02.2005 with letter of 23.02.2005
Claims, Numbers	
1-38	received on 24.02.2005 with letter of 23.02.2005
Drawings, Figures	
1-4	as originally filed

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/GB2004/001778

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	2-22,24-26,28-38
	No:	Claims	1 23 27
Inventive step (IS)	Yes:	Claims	20-22
	No:	Claims	1-19, 23-38
Industrial applicability (IA)	Yes:	Claims	1-38
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Box No. VI Certain documents cited

1. Certain published documents (Rule 70.10)

and / or

2. Non-written disclosures (Rule 70.9)

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following document/s/:

D1: GB-A-1 014 769 (BARNES ENG CO) 31 December 1965 (1965-12-31)

D2: RING F J: "Criteria for thermal imaging in medicine" ENGINEERING IN MEDICINE AND BIOLOGY SOCIETY, 1995., IEEE 17TH ANNUAL CONFERENCE MONTREAL, QUE., CANADA 20-23 SEPT. 1995, NEW YORK, NY, USA,IEEE, US, 20 September 1995 (1995-09-20), pages 1697-1698, XP010214992 ISBN: 0-7803-2475-7

The following documents were not cited in the international search report. A copy of the documents is appended hereto.

D4 = US-A-6127679

D5= " Focal-Plane Arrays and CMOS readout techniques of infrared imaging systems", IEEE Trans. on Circuits and Systems for video technology, Vol. 7, N°4 , August 1997, IEEE , New York (US))

D6= "A reappraisal of the use of infrared thermal image analysis in Medicine, IEEE Transactions on Medical imaging, Vol. 17, N°6, December 1998; IEEE (New York (US)).

The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of Claim 1 is not new in the sense of Article 33(2) PCT.

The document D4 discloses (the references in parentheses applying to this document): a thermal imaging system for quantitative thermal mapping of a scene (fig.1), the system comprising:

- a thermal imaging device
- a first heat source of known temperature and emissivity (20), located within the scene viewed by the thermal imaging device(17,19); and
- a processor(28) adapted to generate a calibrated temperature map of the scene from the data supplied by the thermal imaging device, by determining a correction based on the known temperature of heat source, and applying the correction to data supplied by the thermal imaging device.

Therefore, the subject-matter of Claim 1 and corresponding method Claim 27 as

well as Claim 23 is not new (Article 33.2 PCT).

The subject-matter of Claim 2 differs from D4 in that the calibration heat source is multiple. The problem is how to determine the correction required to calibrate the image more accurately. The solution is found in D1 (page 4, left-hand column, lines 60-63) whereby the calibration means is comprised of a plurality of controlled black body sources. Therefore the subject-matter of Claim 2 and corresponding method Claim 28 doesn't involve an inventive step (Article 33.2 PCT).

Claims 3-5 refer to the measurement of the heat source acting as a reference. It is well known to measure a temperature either by a contact sensor or by an infrared thermometrer. Therefore, the subject-matter of claims 3-5 doesn't involve an inventive step (Article 33.2 PCT).

Furthermore, D1 discloses the adjusting of the heat source temperature by electronic means , and more particularly by resistance heating means (page 4, lines 100-115). Therefore, the subject-matter of claims 6 and 7 doesn't involve an inventive step (Article 33.3 PCT).

D4 discloses also an imaging system wherein the temperature of the heat source is adjustable by a device operating on the Peltier principle (col.2, lines 20-23). Therefore, the subject-matter of Claim 8 doesn't involve an inventive step (Article 33.3 PCT).

D4 discloses also the features of claims 9 and 10. Therefore, the subject-matter of claims 9 and 10 doesn't involve an inventive step.

Dependent claims 11-19 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, the reasons being as follows:

It is well known to use a FPA detector in a thermal imaging system which comprises thermal detectors , like bolometers (see D5) .

Claims 21-22 disclose that a portion of the same object could be the calibration heat sources and another portion could be submitted to temperature variations measurement and appear to meet the requirements of the PCT in respect of novelty and inventive step. The same remark applies to Claim 29 and subclaims.

The application of thermal imaging to skin temperature measurement is known for

a long time (see D6). Therefore, the subject-matter of claims 24-26 and 31-38 doesn't involve an inventive step (Article 33.3 PCT).

Re Item VI
Certain documents cited

Certain published documents

Application No Patent No	Publication date *(day/month/year)*	Filing date *(day/month/year)*	Priority date *(valid claim)* *(day/month/year)*
PCT/GB03/00923	18/09/2003	04/03/2003	08/03/2003

Re Item VIII
Certain observations on the international application

Although claims 1, 27 and 19 have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought in respect of the terminology used for the features of that subject-matter. The aforementioned claims therefore lack conciseness and as such do not meet the requirements of Article 6 PCT.

particularly desirable is monitoring the temperature of metal heat exchangers during testing. Conventional techniques require thermometers to be in contact with the metal heat exchanger which, in practice, allows only a small number of point measurements. What is needed is an apparatus which produces a detailed, spatially-resolved, temperature map with high temperature accuracy.

WO03/077539, for example, proposes a method of calibrating an infrared camera by use of an advance calibration sequence. The method involves exposing the detector to a reference surface at a known temperature and for a known time. This is repeated several times in order to characterise the response of each pixel in the detector array. The results are stored and used to calibrate subsequent measurements made by the detector. The method is particularly adapted for the situation in which the reference surface is, by necessity, at a substantially different temperature to that of the object to be measured. The requirement of a pre-measurement calibration sequence however is undesirable as it results in a complex temperature measurement method and increases the amount of time needed to set up and obtain the measurement.

In accordance with the present invention, a thermal imaging system for quantitative thermal mapping of a scene comprises a thermal imaging device; a first heat source of known temperature and emissivity, located within the scene viewed by the thermal imaging device; and a processor adapted to generate a calibrated temperature map of the scene from the data supplied by the thermal imaging device, by determining a correction based on the known temperature of the heat source, and applying the correction to data supplied by the thermal imaging device.

By providing the imaging system with a known temperature reference point, the data supplied by the

thermal imaging device may be calibrated resulting in a highly radiometric output image. This makes it possible to use uncooled focal plane array detector technology to produce accurate temperature measurements suitable for industrial applications, whilst remaining inexpensive and straightforward to use.

By placing the heat source in the field of view of the thermal imaging device, for example alongside the object whose temperature is to be measured (which also remains in the field of view), calibration and temperature measurement may effectively be carried out simultaneously. This removes the need for an advance calibration sequence and so makes the thermal imaging system easy to use and versatile.

The invention further provides a method of generating a quantitative thermal map of a scene, the method comprising positioning a first heat source of known temperature and emissivity within the scene; imaging the scene using a thermal imaging device; and generating a calibrated temperature map of the scene, by determining a correction based on the known temperature of the heat source, and applying the correction to data supplied by the thermal imaging device.

Alternatively, "natural" objects in the scene may be used as heat sources, in which case the invention further provides a method of generating a quantitative thermal map of a scene, the method comprising:

selecting at least part of an object in the scene, of known emissivity;

measuring the temperature of the at least part of an object, the at least part of an object becoming a first heat source;

imaging the scene using a thermal imaging device; and

generating a calibrated temperature map of the scene, by determining a correction based on the measured

temperature of the heat source, and applying the correction to data supplied by the thermal imaging device.

The invention may therefore be used in a number of different applications, including temperature monitoring of metal heat exchangers. A further important example is in

CLAIMS

1. A thermal imaging system for quantitative thermal mapping of a scene, the system comprising:

a thermal imaging device;

a first heat source of known temperature and emissivity, located within the scene viewed by the thermal imaging device; and

a processor adapted to generate a calibrated temperature map of the scene from the data supplied by the thermal imaging device, by determining a correction based on the known temperature of the heat source, and applying the correction to data supplied by the thermal imaging device.

2. A thermal imaging system according to claim 1 which further comprises a second heat source of known temperature and emissivity, located within the scene viewed by the thermal imaging device and wherein the processor is adapted to generate the calibrated temperature map from the data supplied by the thermal imaging device, based on the known temperatures of both the first and the second heat sources.

3. A thermal imaging system according to claim 1 or claim 2 which further comprises means for measuring the temperature of the or each heat source and communicating the temperature to the processor.

4. A thermal imaging system according to claim 3 wherein the temperature of the or each heat source is measured by a contact sensor.

5. A thermal imaging system according to claim 3 wherein the temperature of the or each heat source is measured by an infrared thermometer.

6. A thermal imaging system according to any of the preceding claims wherein the temperature of the or each heat source is adjustable by electronic means.

7. A thermal imaging system according to claim 6 wherein

the temperature of the or each heat source is adjustable by resistance heating means.

8. A thermal imaging system according to claim 6 wherein the temperature of the or each heat source is adjustable by a device operating on the Peltier principle.

9. A thermal imaging system according to any of the preceding claims wherein the control of each heat source is effected by electronic circuitry local to that heat source.

10. A thermal imaging system according to claim 9 wherein a set-point temperature for control of the or each heat source is communicated from the processor to the electronic circuitry local to that heat source.

11. A thermal imaging system according to any of the preceding claims wherein a temperature range of the thermal imaging device is adjustable by the processor.

12. A thermal imaging system according to claim 11 wherein the temperature range is adjustable by the processor in accordance with the known temperature of the or each heat source.

13. A thermal imaging system according to any of the preceding claims wherein the thermal imaging device comprises a focal plane array (FPA) detector.

14. A thermal imaging system according to claim 13 wherein the FPA detector is an un-cooled FPA detector.

15. A thermal imaging system according to claim 13 or claim 14 wherein the FPA comprises thermal detectors.

16. A thermal imaging system according to claim 15 wherein the thermal detectors are bolometers.

17. A thermal imaging system according to any of claims 13 to 16 which further comprises means for maintaining the temperature of the FPA detector at close to room

temperature.

18. A thermal imaging system according to claim 17 wherein the temperature of the FPA detector is maintained by means of a device operating on the Peltier principle.

19. A thermal imaging system according to any of the preceding claims wherein the FPA detector is cased in a protective housing.

20. A thermal imaging system according to any of the preceding claims wherein the or each heat source has a surface finish substantially identical to that of an object of primary interest in the scene.

21. A thermal imaging system according to any of the preceding claims wherein the or each heat source comprises at least a portion of an object forming part of the scene to be thermally mapped.

22. A thermal imaging system according to claim 21 wherein the temperature of the object is monitored using at least a contact thermometer fitted to the object.

23. A thermal imaging system according to any of claims 1 to 19 wherein the or each heat source is a black body source.

24. A thermal imaging system according to any of the preceding claims, wherein the system is adapted to identify temperature variations in at least part of a target object within the scene, the target object being a living subject.

25. A thermal imaging system according to claim 24, wherein the living subject is a human.

26. A thermal imaging system according to claim 25, wherein the part of the target object is a hand, foot or face.

27. A method of generating a quantitative thermal map of

a scene, the method comprising:

positioning a first heat source of known temperature and emissivity within the scene;

imaging the scene using a thermal imaging device; and

generating a calibrated temperature map of the scene, by determining a correction based on the known temperature of the heat source, and applying the correction to data supplied by the thermal imaging device.

28. A method according to claim 27 further comprising positioning a second heat source of known temperature and emissivity within the scene and generating the calibrated temperature map of the scene based on the known temperatures of both heat sources.

29. A method of generating a quantitative thermal map of a scene, the method comprising:

selecting at least part of an object in the scene, of known emissivity;

measuring the temperature of the at least part of an object, the at least part of an object acting as a first heat source;

imaging the scene using a thermal imaging device; and

generating a calibrated temperature map of the scene, by determining a correction based on the measured temperature of the heat source, and applying the correction to data supplied by the thermal imaging device.

30. A method according to claim 29 further comprising selecting a second at least part of an object in the scene of known emissivity, measuring its temperature such that it acts as a second heat source, and generating the calibrated temperature map of the scene based on the known temperatures of both heat sources.

31. A method according to any one of claims 27 to 30, which further comprises monitoring the temperature of the or each heat source and communicating the temperature(s) to a processor.

32. A method according to any of claims 27 to 28 or 29 to

30 and 31, further comprising identifying temperature variations in at least part of a target object within the scene, the target object being a living subject.

33. A method according to claim 32, wherein the living subject is a human.

34. A method according to claim 33, wherein the part of the target object is a hand, foot or face.

35. A method according to any of claims 32 to 34, wherein the method further comprises issuing a signal if the measured temperature of the subject is in excess of a threshold.

36. A method according to claim 35, wherein the method is repeated for a number of different living subjects so as to distinguish those with an elevated body temperature with respect to those exhibiting a normal body temperature.

37. A method according to any of claims 27 to 28 or 29 to 30 and 31 to 36 which further comprises communicating a set-point temperature to the or each heat source, and thereby controlling the temperature of the or each heat source.

38. A method according to any of claims 27 to 28 or 29 to 30 and 31 to 37 which further comprises controlling a temperature range of the thermal imaging device, in accordance with the temperature of the or each heat source.